Development of Potential Offsets Related to Agricultural Carbon Management (ACM)

Introduction

This paper explores the potential to develop meaningful carbon offsets in conjunction with voluntary agricultural carbon management practices that increase the stored pool of carbon in soils and vegetation. Historically, many soil management practices have "oxidized" native soil carbon, emitting it to the atmosphere as CO_2. Improved management systems and new technology can reverse this trend and restore atmospheric carbon to soils. Establishing a carbon offset program for land management practices is specifically noted as an area for consideration under Section 3(g) of EESB2815.

Basis for Selection

Overall Considerations

Over 15 million acres of land is managed by Washington farmers and ranchers, more than half of which is dedicated to a crop production system (including fallow).[1] In aggregate, these lands represent a substantial *potential* "sink" for atmospheric carbon that could help the state achieve its greenhouse gas emission reduction targets. In addition, the Department of Ecology's *Biomass Inventory*[2] estimates 16.9 million dry tons of *under-utilized* organic material in the state, an increased fraction of which could be applied to agricultural lands to increase soil carbon levels.

The balance of soil organic matter (i.e. sequestered carbon) is a function of carbon inputs, residue management, and disturbance. Traditional agricultural management practices such as inversion tillage and residue burning / removal have reduced native soil carbon pools in many soils by at least 50%. Improved understanding of soil carbon dynamics and improved soil management practices / technologies make it possible to increase the sequestration and storage of atmospheric carbon in soils and vegetation. These practices and technologies include "direct-seeding" (i.e. reduced tillage, no-till), improved cropping systems, application of organic residuals (i.e. composts, biochar, digested manure, etc.), improved residue management, and use of cover crops. The adoption of these types of agricultural carbon management practices under the right conditions and in the right combination, can increase the pool of carbon stored in soils / vegetation relative to conventional practices. Using a conservative rate of 417 lbs C sequestered / acre / year for dryland, reduced tillage grain production from the low rainfall region of Washington [3], use of improved carbon management practices on 1 million acres could result in $0.69 MMTCO_2eq$ annually. Sequestration rates as high as 567 lbs per acre have been reported for dryland, no-till grain production higher rainfall zones of Eastern Washington[4], 696 lbs per acre for the use of a mustard green manure cover crop in an irrigated potato rotation in Central Washington[5], and 2,349 lbs per acre for irrigated switchgrass production in Central Washington[6] -- all indicating substantially higher soil carbon storage potential than used for our base estimate.

Potential Barriers to Inclusion

Additionality

The Agricultural Sector Carbon Market Workgroup (ASCMW) is keenly aware that the issue of additionality related to agricultural carbon storage offset projects is highly controversial, and in spite of extensive efforts to define the theory it remains unsettled in practice in regional, national, and international policy discussions. In principal, a practice is considered to have "additionality" if it otherwise would not have happened under a "business as usual" case. However, determining additionality for agricultural carbon management practices can be difficult because:

1. The inherent variability of agricultural enterprises between regions and within a region;

2. Most “climate-friendly” agricultural practices are adopted [or not adopted] for many additional reasons beyond the potential for reducing GHG emissions or storing carbon; and
3. The practice change / technology is only one [necessary] factor in a set of conditions that lead to increasing soil carbon storage.

The goal of determining additionality *should be* to ensure that offset projects are resulting in *actual increases of carbon storage above and beyond business as usual*, and not simply the adoption of a prescribed technology or practice. Several methods for determining additionality for offset projects have been proposed and are described at length elsewhere.[7] Generically applying these universal tests to determine additionality for agricultural carbon management practices in Washington State, without giving due consideration to the particular conditions of the region [and within region] or context of the agricultural production system, could dramatically reduce the potentially available agricultural carbon offsets our farmers could provide into a regional carbon market mechanism and may put Washington farmers and ranchers at a disadvantage to others.

The use of any improved carbon management practices is not regulated, and the decision to adopt and continue a given practice is often determined by evolving economic, technical or biophysical conditions (ie. increased weed or disease pressure, cost or efficacy of chemical herbicides, risk). The *initial adoption* and *continuation* of an improved carbon management practice represents a voluntary [and often substantial] risk assumed by the producer. While there may be many other benefits of a practice, the larger context of risk may dictate that the best management decision is to revert to the conventional practice in the absence of an incentive to continue the improved practice, consequently undoing the “carbon offset” benefit. For instance, organically managed orchard land (a practice that could have carbon implications due to the application of organic amendments such as compost) in the state has oscillated due to volatility in the market demand for organic apples. The goal of providing measurable, verifiable carbon offset credits is to help provide the incentive to the producer to continue the use of practices and technologies that result in the actual storage of additional carbon over time in spite of the larger context of risk. Artificially determining additionality on the basis of the adoption of a practice or technology does not reflect the reality of the decision-making framework that a producer uses. Many of the “improved carbon management” practices of interest in our region have higher costs and risk due to technical, biological or market-based barriers.

A number of progressive Washington farmers have voluntarily accepted the risks of adopting improved carbon management practices, leading early action that has resulted in increasing the stored pool of carbon in the soils they manage. Much like the conservation set aside lands described in a separate ASCMW document, this represents a potential source of new emissions if these lands revert to business as usual practice. Prohibiting these early actors from participating in future carbon offset projects through a “practice-based” determination of additionality would reduce the potential incentives that would avoid the release of carbon stored through early action. Keeping the determination of addtionality based on the actual carbon being stored, enables these producers to continue the set of practices that ensure the avoided release of carbon.

Technology and / or practices that are utilized to sequester carbon in soils or vegetation can have consequent impacts [positive and negative] on direct and indirect emissions of other GHG’s. For instance, use of no-till technology is generally associated with a reduction of fossil fuel related emissions due to decreasing the number of “passes” across a field. Also, in certain cases, the use of no-till technology (or other carbon management technology) may actually lead to marginal increases in nitrous oxide emission due to the stimulation of greater microbial activity. To the extent possible, based on the state of the existing science, efforts need to be made to add or discount the consequent impacts of a carbon management practice to reflect an accurate picture of the change in full carbon accounting for a system.

Baselines

Washington’s agricultural soils have tremendous variability due to numerous factors including parent material, agri-climatic zone, and management. Accurate initial soil carbon baselines for a site are critical for estimating the potential soil carbon sequestration – regardless of the practice or management system of interest. Existing, generalizable [state / region-wide] estimates / inventories of initial soil carbon levels do not provide accurate and reliable baselines for estimating soil carbon offset projects. For instance, soil organic matter levels in existing soil survey databases are usually reported as a range for a given soil type. The resulting estimate of potential soil carbon storage – assuming the same site, management practices and climatic conditions – can be positive [carbon stored] or negative [carbon lost] depending on whether the lower or higher initial value is used. For instance, a simulation using *C-Farm*[8] for a no-till winter wheat-based crop rotation in Colfax, Washington resulted in a gain of 671 pounds / CO2eq / acre / year or a loss of 259 pounds / CO2eq / acre / year depending on whether the higher (3.43%) or lower (1.60%) soil organic matter level from the NRCS STATSGO database was used as the initial baseline value. While an "average" of the range may prove to be useful for the purpose of a state-wide inventory and / or estimate of soil carbon sequestration potential, it may seriously over or under-represent the actual results for a specific carbon-offset project.

More accurate baseline data does exist for several sites / cropping systems – generally associated with studies by WSU or USDA scientists – and further efforts are being made to supplement the database. Additionally, many producers have long-term soil data sampled from their own fields for fertility recommendations [generally less than 1 ft depth] that may contain soil organic matter estimates – though this information is not in the public domain. As carbon market opportunities emerge, it is expected that an accurate baseline database for the state can be filled out. Having accurate, initial soil carbon levels is critical to documenting whether carbon is actually being stored in a given field, based on the set of practices being used. While generalizable numbers can be useful for early carbon offset projects, the need for developing a robust database of initial carbon levels is essential for ensuring long-term viability of carbon offset projects.

The ASCMW also believes that an appropriate initial date needs to be established as a baseline date after which carbon offset projects can be marketed. Actual carbon stored *after* the baseline date of __X____should be eligible for credit.

Measurement, Monitoring, and Verification

The ability to affect [increase or decrease] carbon pools in the soil and vegetation is a well-documented phenomenon in the scientific community[9,10,11,12,13]. As the understanding of the specific impacts of management on carbon pools has evolved, sophisticated models have been developed to simulate and predict the effects of a management practice. Given a sufficient time horizon and accurate parameters (including initial soil carbon levels), models can provide extremely accurate and useful estimates of the average changes that a given practice(s) will have on the soil carbon pool on an annual basis[14]. In fact, with sufficient available input parameters, models are far more accurately at predicting changes in the soil carbon pool for a specific site than using existing, regional carbon storage rate tables.

The conventional methodology for ensuring the accuracy of model outputs is to have sufficient long-term, site-specific data for calibration and corroboration (to calibrate the model you compare a simulation to site-specific data). Model performance can be evaluated using sensitivity indicators, such as root mean square errors (RMSE), the ratio of RMSE to the observed mean (an indication of the relative magnitude of the error), and the Willmott index of agreement.[15] Each of these indicators provides a quantitative measurement of confidence that can be used to determine whether the model will reliably predict the management impacts of a project under similar conditions as the site-specific calibration data. In the absence of site-specific calibration data, the use of two or more models to simulate the effects of management can improve the confidence in the modeled outputs.

The greater the availability of calibration data, the greater the confidence will be in the accuracy of modeled outputs. A tiered system could be employed that correlates model confidence with percentage value of credits to incentivize the use of well-calibrated models. For instance, full credit could be given for model results with greater than 90% confidence level, 75% credit for models with greater than 75% confidence, and 50% for models with less than 75% confidence level.

Models can also be used to estimate the impact of applying organic residuals such as manure, composts, biochar, biosolids, etc. – so long as sufficient data exists to characterize the material (ie. decomposition, mineralization rates, etc.). Efforts to document the impact of several types of materials are underway or previously published.

Specific Policy and Technical Recommendations

General

There is great potential for agricultural carbon management offset projects to contribute substantially to the state's goal for reducing greenhouse gas emissions.

ACM-1 **Ag Carbon offset projects should be allowable for any set of practices / technologies that lead to the actual storage of carbon in soils or long-term vegetation, given that they are additional, measurable and verifiable. Practices /technologies include, but are not limited to: "Direct-seeding" (ie. no-till, reduced till, high-residue), use of cover crops and/or perennials, improved residue management (including residue end uses), and the application of organic residuals (ie. compost, biosolids, manure, biochar, etc.).**

Additionality

ACM-2 **The determination of additionality should be focused on the "performance" of a proposed offset project, rather than the "practice" being implemented.**

ACM-3 **The determination of additionality should be applied on a project-specific basis to ensure accurate, equitable assessment of the individual characteristics of a project.**

ACM-4 **The determination of additionality should focus on the *barriers* to the adoption / continuation of a practice / technology – effectively leaving room for assessing within region variability as well as changes in the larger agricultural management context that drives on-farm decision-making.**

ACM-5 **The determination of additionality should credit the continuation of a practice that effectively ensures the "avoided release" of existing carbon stored due to early action by farmers.**

ACM-6 **Consequent impacts on other agricultural greenhouse gas emissions due to the implementation of a agricultural carbon storage project should be credited or debited to the project accordingly.**

Baselines

ACM-7 **Early carbon offset projects should be allowed to use either generalizable and/or published initial soil carbon data in combination with site-specific initial soil carbon data to the extent possible for establishment of soil carbon offset projects.**

ACM-8 **Development of a state-wide database of initial soil carbon level data should be encouraged – that utilizes both intensive research-based site studies as well as more extensive private-domain data – to improve the accuracy of offset project estimates over time.**

Measurement, Monitoring, and Verification

ACM-9	**The use of soil / plant / agroecosystem models in combination with a reasonable expectation for site-specific soil sampling to validate / corroborate the model outputs (including baselines for initial soil carbon levels) should be considered a reasonable methodology for estimating and measuring soil carbon offset projects. A tiered system should be employed that discounts the value of the credit on the basis of the confidence level of the modeling results.**
ACM-10	**Efforts to develop primary data to calibrate models to document the carbon storage impacts of land-applied organic materials should be encouraged.**
ACM-11	**Projects should be required to have 3rd party certification to ensure that the appropriate contractual practices are performed.**

Data Development Needs

There are two types of data development "needs" relative to agricultural carbon offset projects:

1) "Calibration / characterization" data relative to the impact of a given practice that can be used to calibrate a model. For instance, intensive, site-specific data sampling is necessary to characterize the carbon dynamics for a specific cropping system / practice / organic amendment. Extensive sampling data exists for high-rainfall dryland cropping systems and to a lesser extent low-rainfall cropping systems, and the west side. Extensive sampling exists for some irrigated cropping systems. Additional sampling is targeted for improved pasture in low-rainfall conditions, improved irrigated cropping systems and orchards. Efforts are underway to systematize the availability of existing calibration data.
2) Distributed or extensive "initial soil carbon" levels for agricultural lands that would be included in a carbon offset project. These could be sourced from generalized soil surveys, existing soil sample data, or could be collected with targeted sampling.

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[8] C-Farm is a soil-carbon sub-routine of WSU's CropSyst model: http://www.bsyse.wsu.edu/cropsyst/ . A detailed description of CropSyst can be found in: Stockle, C. O., Donatelli, M. and Nelson, R. 2003. CropSyst, a cropping systems simulation model. *Europ. J. Agronomy* 18:289-307. The specific simulation cited as an example in this document was generated in cooperation between WSU's Climate Friendly Farming Project and members of the Pacific Northwest Direct Seed Association. The simulated 4-year crop rotation was winter wheat – spring wheat – spring barley – chemical fallow.

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